The Parity and Factor Strata of Fertility Decline; Layer Decomposition Analysis of Reproductive Life Course Transition in Japan[1]

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Abstract

Fertility rate is sum of the probabilities of having child by birth order, and each of the probability is composed of some structural and behavioral factors such as marital status and reproductive behavior of married couples. Effects from some socioeconomic factors on fertility change by way of those intermediate factors are major concern. All of those phenomena should be observed amongst the age and time space to understand what happened to humans which is life course being. Fertility change is, therefore, viewed from numerous dimensions. Lexis mapping serves as a functional screen to express multi-dimensional changes in fertility if it is used with techniques of the decomposition. I analyze the fertility decline in Japanese female cohorts using the logistic regression framework to decompose the probabilities' change into effects from the factors such as marriage delay or educational upgrading. They revealed detailed process of fertility reduction.

Extended Abstract

Introduction

Fertility rate is sum of the probabilities of having child by birth order, and each of the probability is composed of some structural and behavioral factors such as marital status and reproductive behavior of married couples. Fertility change is, therefore, induced by alteration of those probabilities and factors. Effects from some socioeconomic factors on fertility change by way of those intermediate factors are major concern. All of those phenomena should be observed amongst the age and time space to understand what happened to humans which is life course being. Fertility change is, therefore, viewed from numerous dimensions, which is hard to grasp in concise manner. Lexis mapping serves as a functional screen to express multi-dimensional changes in fertility if it is used with techniques of decomposition of factor's effect on fertility changes. I demonstrate the technique to describe and analyze the fertility decline in Japanese female cohorts using the logistic regression framework to decompose the probabilities' change into effects from the factors such as marriage delay or educational upgrading.

The (Second) fertility transitions featured by decline to the below-replacement level have been universally witnessed in the major domains of the developed world during the last quarter of the Twentieth century. Among them Japan is a country with one of the lowest fertility today. One of the unique features of its fertility decline, however, has been

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the stability in marital fertility. It is known that the decline in fertility rate since mid 1970's had been exclusively caused by the transformation of marriage behavior such as delay and decrease until late 1980's (Kaneko 1999). This has given the Japanese transition a unique position that the fertility decline has been led solely by change in partnership formation without any change in reproductive life after marriage unlike in Europe and America until around 1990. This is an important indication of alternative transition path to the lowest fertility. However certain decline in marital fertility finally in Japan has been witnessed during 1990's. Does this indicate the onset of new phase in the fertility transition following the marriage transformation? Close scrutiny of this process should be highly informative for study of the fertility transition, and even imperative, since many other counties, Asians in particular, seem to follow similar transition path even in imperative manner in coming decades.

This paper is to attempt to reconstruct history of Japanese fertility by measuring the probability having child of each birth order along with 48 years of female birth cohorts by age with data from a series of national representative fertility surveys conducted over 25 years. Fertility changes by single year of cohorts and age are mapped on the Lexis plane, by birth order if necessary, to view what is happening to the reproductive behavior. Since number of observing dimensions are relatively large, various facets of the phenomena are examined by using some other visual arrangements. Furthermore, in order to measure female behavioral change correctly, effects of compositional changes in exogenous factors such as marriage delay and/or educational upgrading is eliminated by applying the logistic regression model to the probability having child of each birth order.

Visual representation and the standardized techniques with the logistic regression model both work well to understand what is happening to the Japanese fertility. They revealed detailed process of onset of marital fertility reduction, indicating who, when, which birth order, and how much change in reproductive behavior is initiated.

Data: National Fertility Surveys

The dataset that I use in this analysis is built from six surveys among the National Fertility Survey (NFS) series, which have been conducted by National Institute of Social Security and Population Research every 5 year (NIPSSR 2003). Birth histories of first-marriage couples for wife's cohorts born in 1928 through 1975 are employed from The Seventh (1977) through Twelfth (2002) survey in this extended abstract. I add the dataset from the Thirteenth (2005) survey in full paper to extend observed cohorts by few years.

Method: The Logistic Regression Model for Removal of Exogenous Effects

The probability having child of each birth order and (therefore) the average number of children for couples are expressed in terms of the logistic regression model with exogenous factors. The probability having n-th order child by some age of wife (say age 35) for wife i is given by;

$$\ln p_{i,n}/(1-p_{i,n}) = \beta_{n,0} + \sum_{j=1}^{k} \beta_{n,j} X_{i,j} + \sum_{m=1}^{k_m} \gamma_{n,m} a_i^m + \sum_{c=1}^{k_c} \delta_{n,c} Y_{i,c} + e_{i,n}$$

where a_i , $X_{i,j}$, $Y_{i,c}$ are age at marriage, dummy for covariates, and cohort dummy for *i*, $\beta_{n,j}\ (j=1\cdots k), \gamma_{n,m}\ (m=1\cdots k_m), \delta_{n,c}\ (c=1\cdots k_c)$ are regression coefficients for those regression variables(k, k_{m}, k_c are number of categories of each variable, regression coefficients for reference categories are zero), and $e_{i,n}$ is regression error. Then

The probability of having the n-th child (observed): $p_n = 1/\left[1+\exp\left\{-(\beta_0+\delta_c)\right\}\right]$

The probability without effect of marriage delay: $p_{n|M^-} = 1/\left[1+\exp\left\{-(\beta_0+\delta_{c|M^-})\right\}\right]$

The probability without effect of educational upgrading: $p_{n|E^-} = 1/\left[1+\exp\left\{-(\beta_0+\delta_{c|E^-})\right\}\right]$

The probability without both effects: $p_{n|EM^-} = 1/\left[1+\exp\left\{-(\beta_0+\delta_{c|EM^-})\right\}\right]$

Total effect of marriage delay: $\nabla\hat{p}_{n|M} = \hat{p}_n - \hat{p}_{n|M^-}$, Pure effects of marriage delay: $\nabla\hat{p}_{n|M^*} = \hat{p}_{n|E^-} - \hat{p}_{n|EM^-}$, Total effect of educational upgrading: $\nabla\hat{p}_{n|E} = \hat{p}_n - \hat{p}_{n|E^-}$, Pure effects of educational upgrading: $\nabla\hat{p}_{n|E^*} = \hat{p}_{n|M^-} - \hat{p}_{n|EM^-}$, Common effect: $\nabla\hat{p}_{n|EM^*} == \hat{p}_n - \hat{p}_{n|M^-} - \hat{p}_{n|E^-} + \hat{p}_{n|EM^-}$, Effect of marital behavioral change: $\nabla\hat{p}_{n|B^*} = \hat{p}_{n|EM^-} - \hat{p}_n[0]$, ($\hat{p}_n[0]$ is the probability of reference cohort).

Then, reduction of probability having n-th child is decomposed as follows,

$$\Delta p_n = \nabla p_{n|E^*} + \nabla p_{n|EM^*} + \nabla p_{n|M^*} + \nabla p_{n|B^*}$$

Change in the average number of children is sum of those effects by birth order.

Results

The parity and factor strata of fertility decline in Japan are visualized by the layers of decomposed effects of Reproductive Life Course Transition in Japan. as shown in Figure 1-

Figure 1 Reduction in the Age-specific Fertility Rate of Japanese Women by Age and Cohort(Birth Year) since Cohort born in 1935

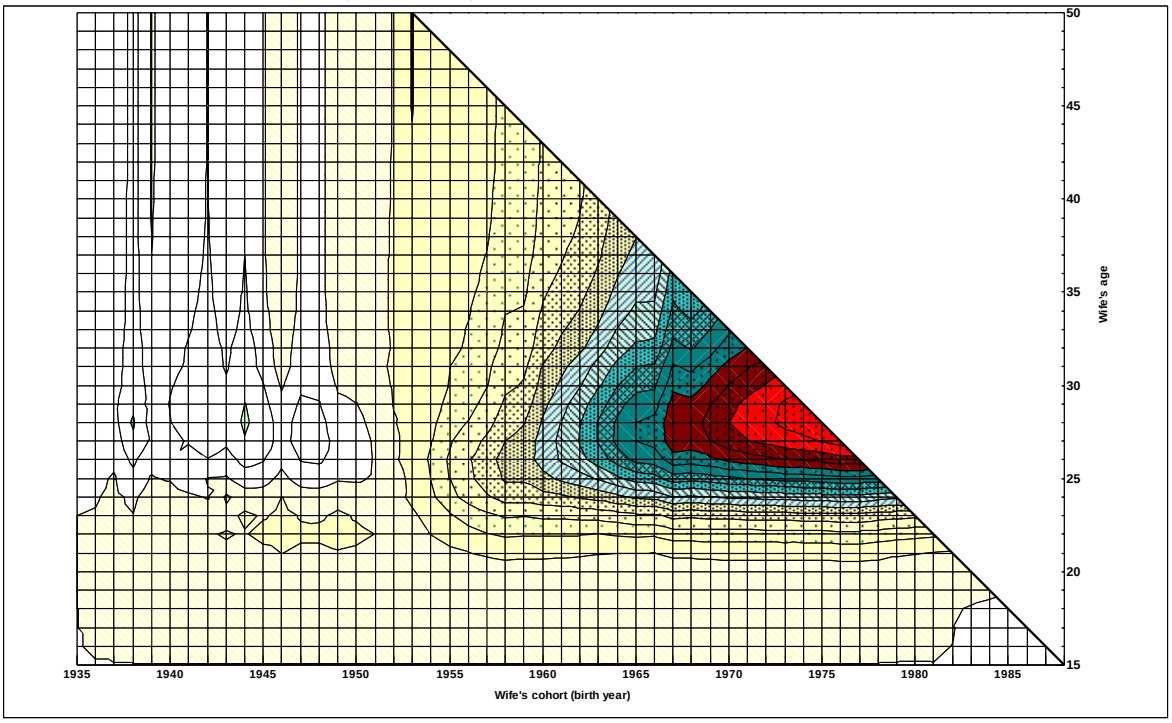
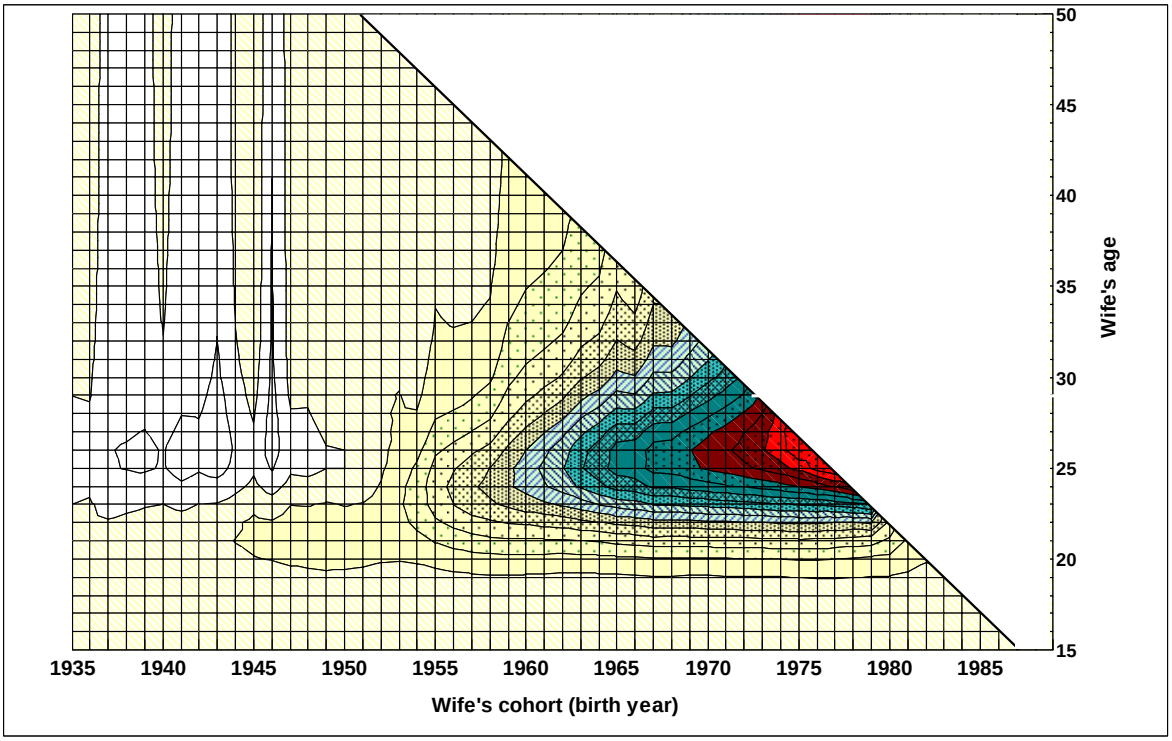
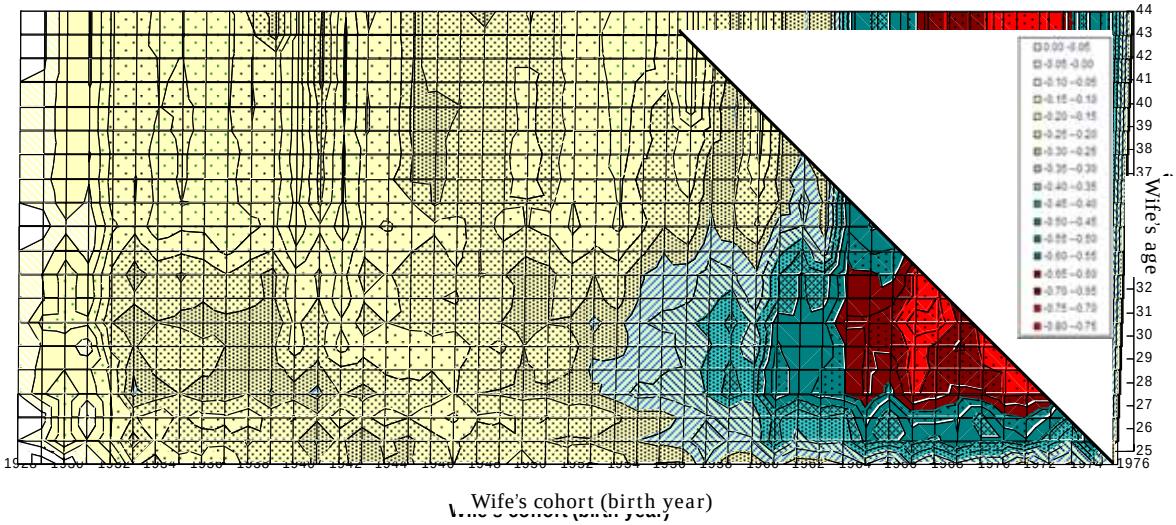


Figure 2 Reduction in the First Marriage Rate of Japanese Women by Age and Cohort(Birth Year) since Cohort born in 1935



Reduction in the average number of children ever born among the first-married couples at each wife's age (ranged 25 to 44) from that of wife's cohort born in 1928 is mapped on the age-cohort coordinates plane in Figure 1. The larger the reduction turn out to be, the darker the paint pattern appears. The only visual representations of the results are presented below in this section. The implications are presented and discussed collectively in the next section of summary and conclusion.

Figure 3 Reduction in the Average Number of Children Ever Born for a Married Couples by Wife's Age and Cohort(Birth Year) since Cohort born in 1928



Note: Reduction in the average number of children ever born among the first-married couples at each wife's age (ranged 25 to 44) from that of wife's cohort born in 1928 is mapped on the age-cohort coordinates plane. The larger the reduction turn out to be, the darker the paint pattern appears. There is white area in the plane for cohort born after 1957, since they have not reached age range at the time of the latest survey.

Figure 4 Reduction in the Average Number of Children Ever Born for a Married Couples Caused by Wife's Educational Upgrading by Wife's Age and Cohort(Birth Year) since Cohort born in 1928

Wife's age

Wife's cohort (birth year)

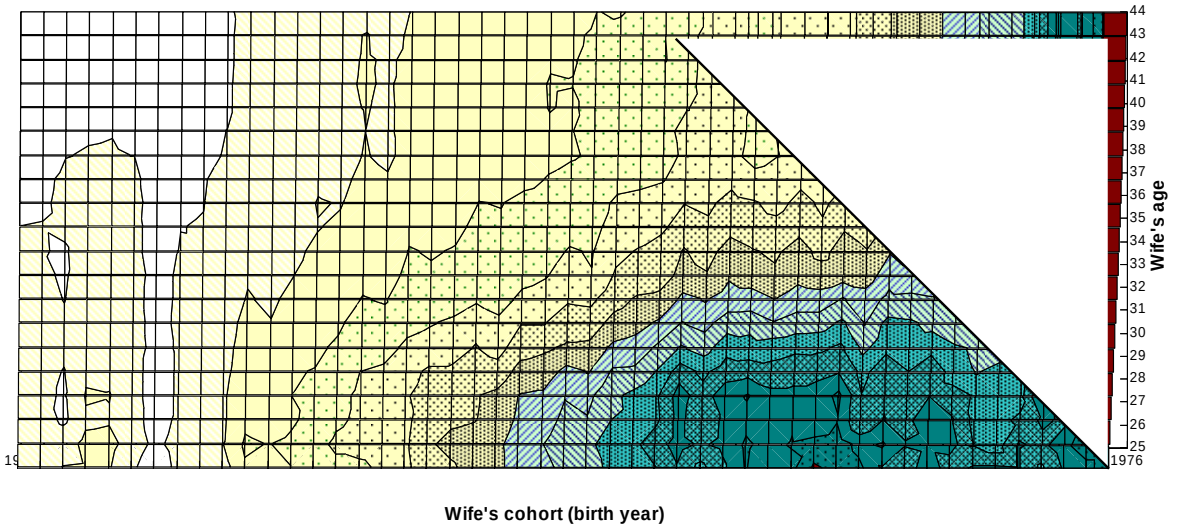


Figure 5 Reduction in the Average Number of Children Ever Born for a Married Couples Caused by Marriage Delay (excluding Effect of Educational Upgrading) by Wife's Age and Cohort(Birth Year) since Cohort born in

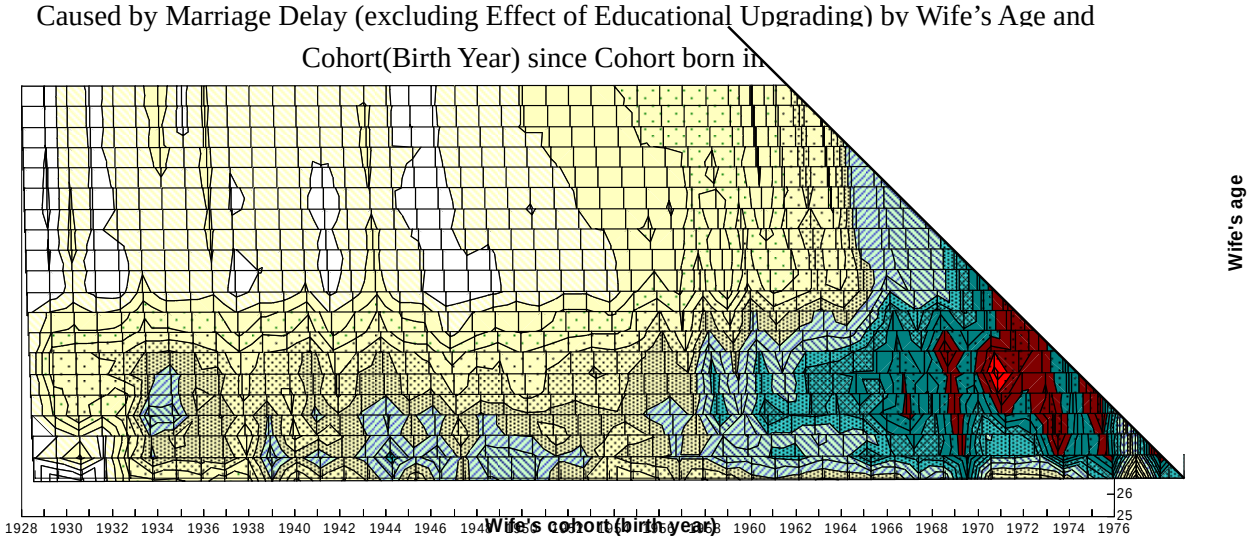


Figure 6 Reduction in the Average Number of Children
Caused by Couples' Behavioral Changes by Wife's Age and Cohor in
1928

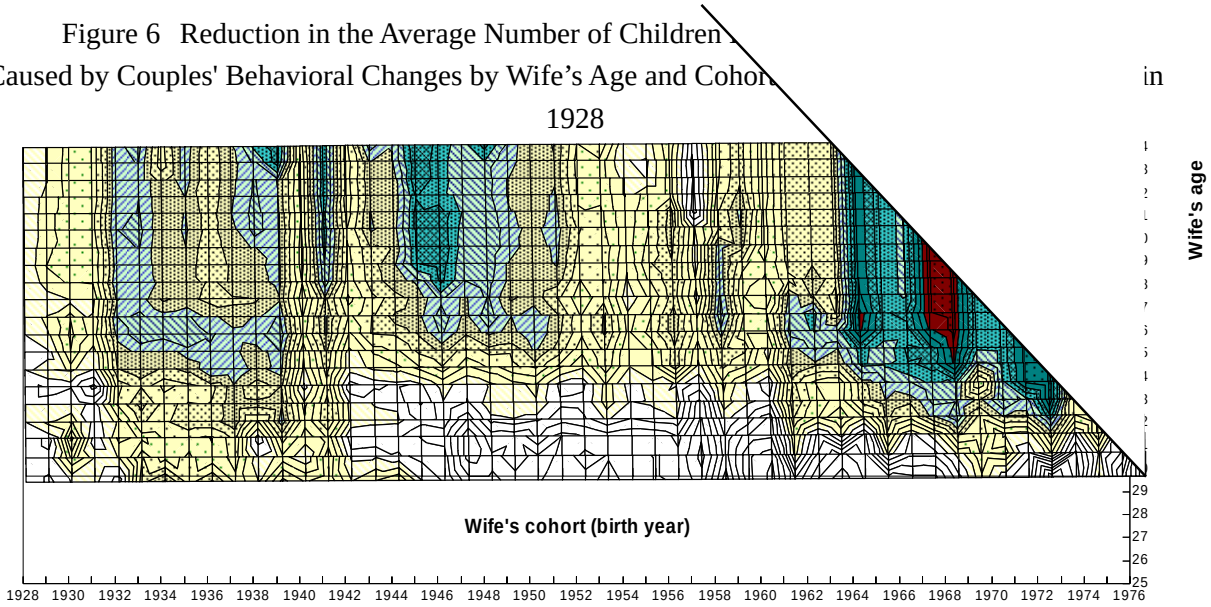


Figure 7 Reduction in the Probability having First Child for a Married Couples by Wife's Age and Cohort(Birth Year) since Cohort born in 1928

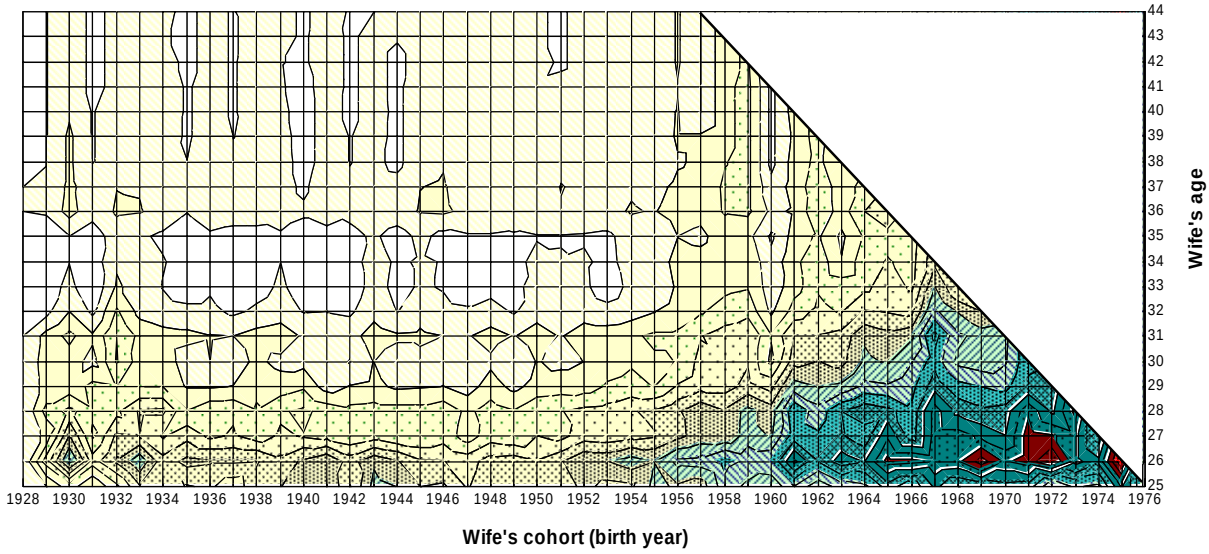


Figure 8 Reduction in the Probability having First Child for a Married Couples Caused by Wife's Educational Upgrading by Wife's Age and Cohort(Birth Year) since Cohort born in 1928 by Wife's Age and Cohort(Birth Year) since Cohort born in 1928

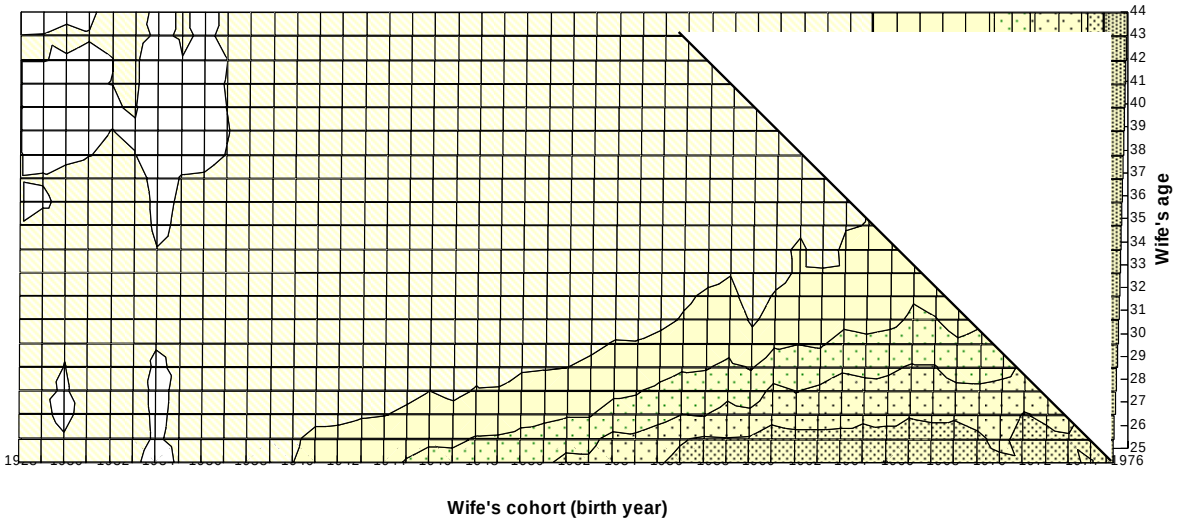


Figure 9 Reduction in the Probability having Second Child by Wife's Age and Cohort(Birth Year) since Cohort born in 19

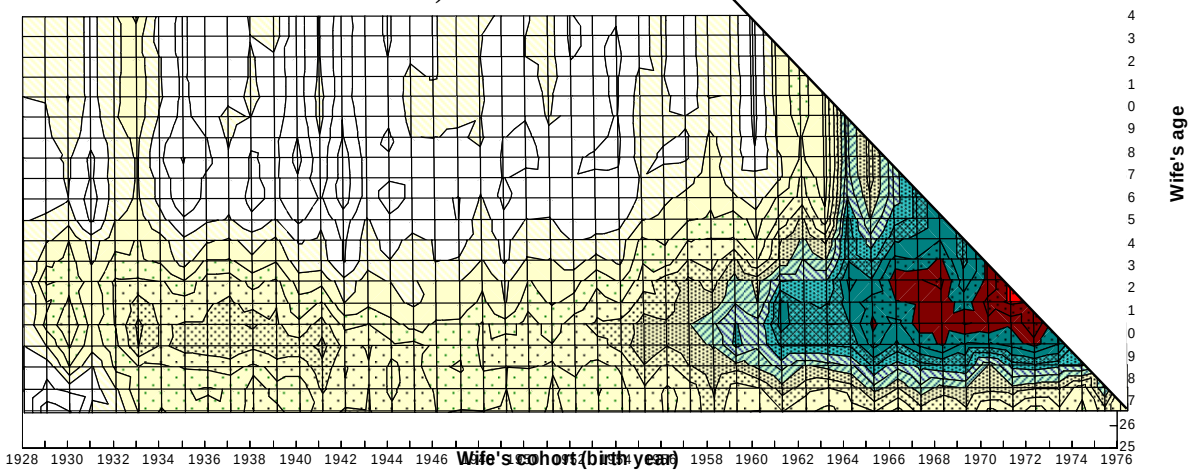


Figure 10　Reduction in the Probability having Second Child for a Married Couples Caused by Wife's Educational Upgrading by Wife's Age and Cohort(Birth Year) since Cohort born in 1928 by Wife's Age and Cohort(Birth Year) since Cohort born in 1928

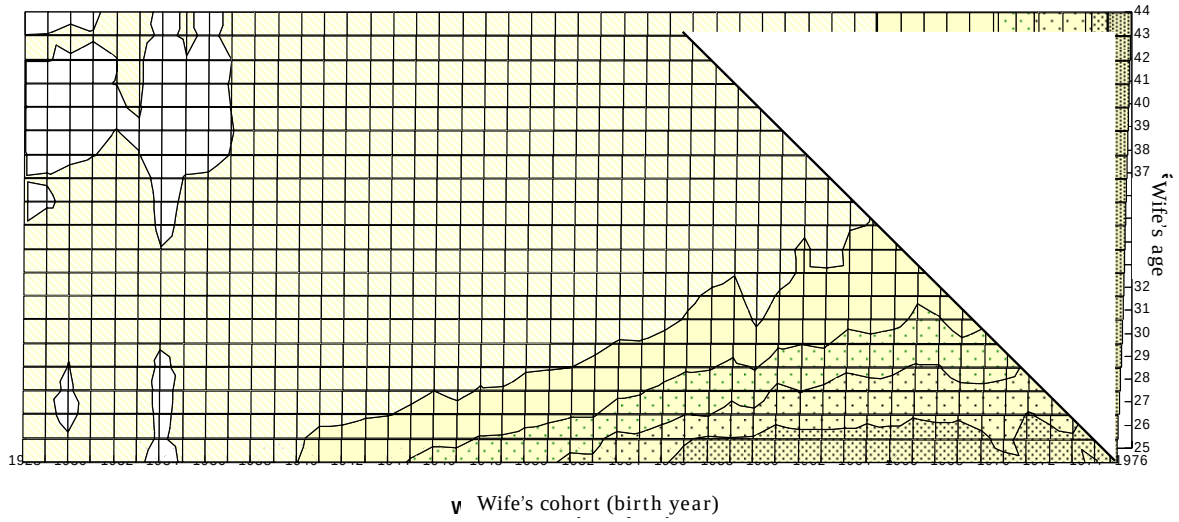
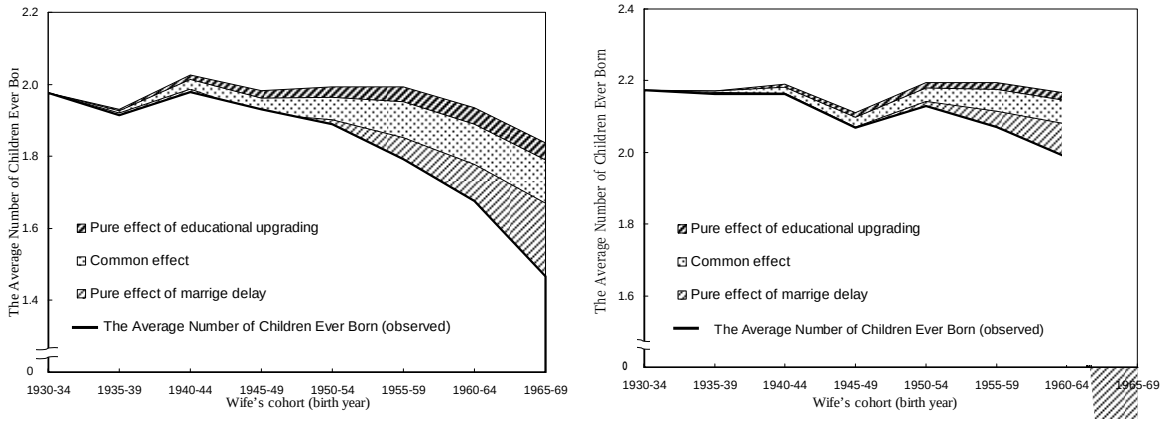


Figure 11　The Average Number of Children Ever Born by Wife's Cohort (Birth Year) at Age 32 and 37: Observed and the Removed with Effects of Marriage Delay and Education Upgrading

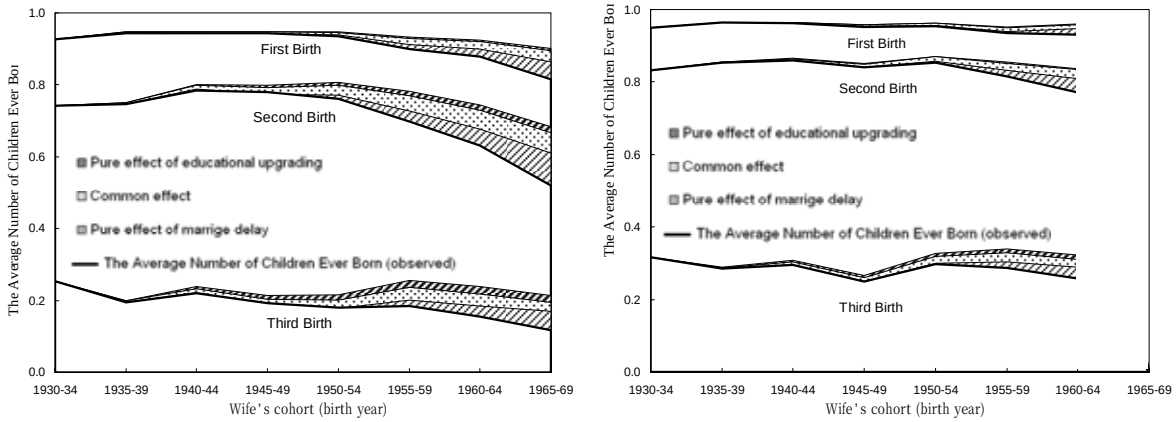
(1) At Wife's Age 32　　(2) At Wife's Age 37



Note: Transition of the average number of children ever born for the first-married couples by wife's cohort (lowest thick line), at two ages 32 and 37 and the estimated counterparts from removal of the effects of marriage delay and educational upgrading (their pure effects and the common effect) are shown. For instance, if it were not for marriage delay and educational upgrading among successive cohorts since the reference cohort (1930-34), the average would have followed the up-most lines. The common effect should be the part of marriage delay effect originated from educational upgrading.

Figure 12 The Probability having First-Third Child by Wife's Cohort (Birth Year) at Age 32 and 37: Observed and the Removed with Effects of Marriage Delay and Education Upgrading

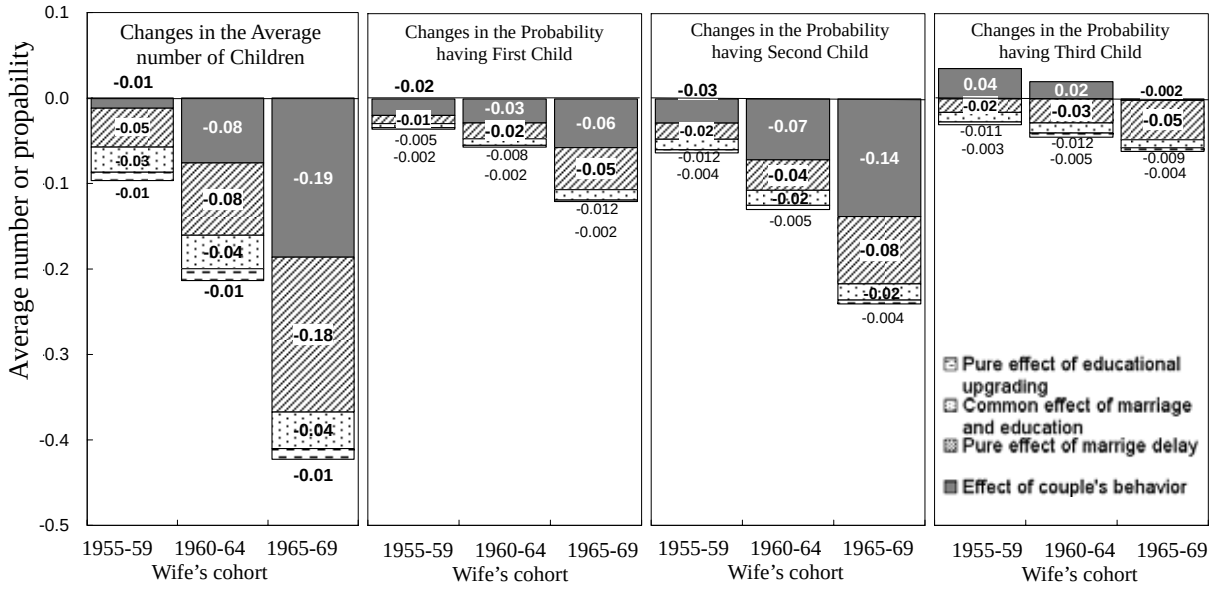
(1) At Wife's Age 32 (2) At Wife's Age 37



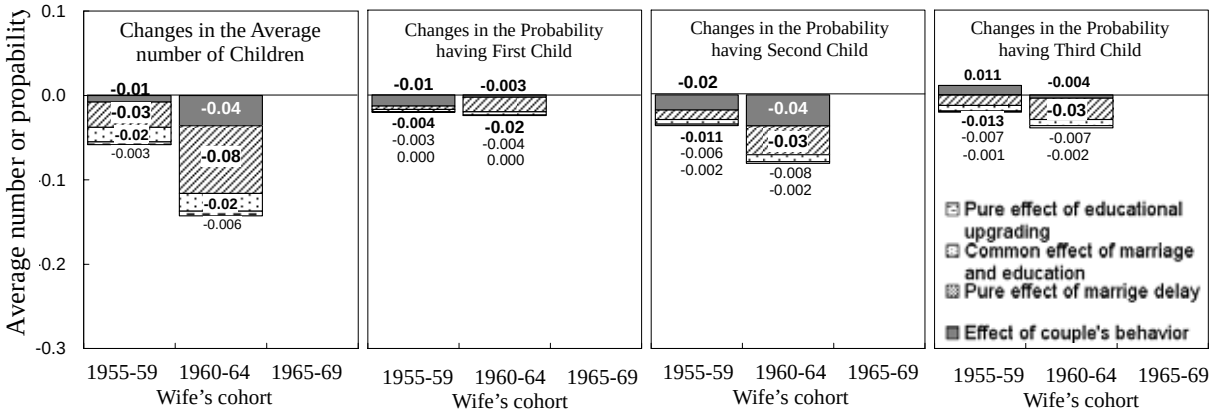
Note: Transition of the probability having first, second and third child for the first-married couples by wife's cohort, at two ages 32 and 37 and the estimated counterparts from removal of the effects of marriage delay and educational upgrading (their pure effects and the common effect) are shown. For more notes, see footnote of Figure 3.

Figure 13 Reduction and its Breakdown in the Average Number of Children Ever Born and in the Probability having First to Third Child by Wife's Cohort since Cohort born in 1950-54

(1) At Wife's Age 32



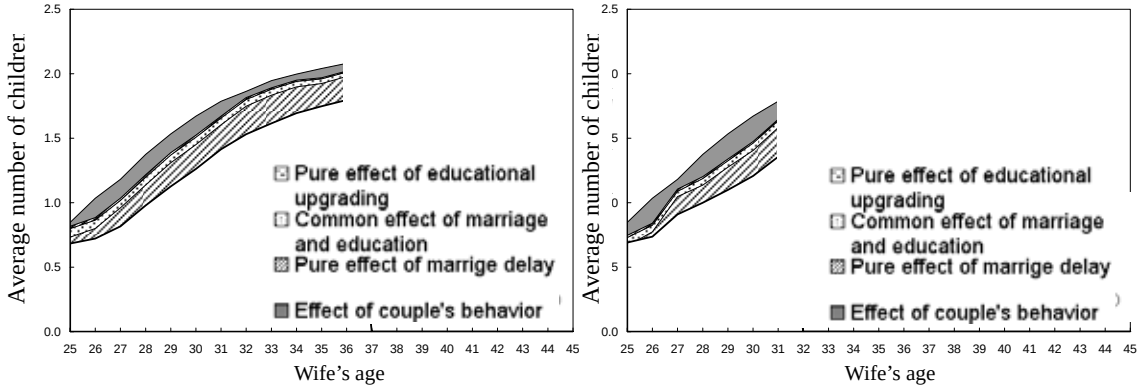
(2) At Wife's Age 37



Note: Reduction in the average number of children ever born and probability having first to third child and their breakdown by factor effects among the first-married couples at each wife's age (32 and 37) from that of wife's cohort born in 1950-54 is shown.

Figure 14 Reduction and its Breakdown in the Average Number of Children Ever Born by Wife's Age since Cohort born in 1950

(1) Cohort born in 1965 (2) Cohort born in 1970



Summary and Conclusion

In this paper, the history of Japanese marital fertility along with 48 years of wife's birth cohort since cohort born in 1928 is reconstructed by means of six national representative surveys extended over 25 years. As a result, detailed process of onset of the recent marital fertility reduction is revealed. An outline is as follows. (1) Until cohort (born in) 1950, there has been almost no change found in marital fertility, though educational upgrading started to have slight effect on marital fertility during cohorts born in 1940s. (2) Marriage delay started by cohort 1952/53 (Kaneko 2003) having influences on the timing of having first and second child, however, without changing the completed fertility for cohort born in 1950s. They caught up to the previous level by age 40. Effect of educational upgrading expanded until cohort 1957 having little change thereafter. The probability

having third child showed an slight upward tendency during cohorts 1952-58 followed by recession to the previous level. (3) After cohort 1960 the pace down seen before age 35 becomes conspicuous and it gradually remained until late 30s. For cohorts 1960-64 the catch up to the level of the previous cohorts is not enough at age 37. The effect from couples behavioral change become large (36% at wife's age 32, 25% at age 37), though the effect of marriage delay is still substantial (58% at age 32, 70% at age 37%). (4) For cohorts born after 1965, the pace down before age 35 becomes even outstanding (-0.4 children from the previous 5-year cohort at age 32). The effect from couple's behavioral change expanded to 44% at age 32. Effect on second child is greater than other birth order implying diffusion of only child family in these young cohorts. Similar but not extending traits are found in succeeding cohorts born in early 1970s.

These information are naturally crucial to understand the process of Japanese fertility decline, and to devise a state countermeasure against undesirable prospects. But they may also provide useful resources for studying process of a specific type of fertility transition, which would be experienced by many other counties, Asians in particular.

From the methodological point of view, this paper first demonstrates effectiveness of the Lexis mapping and some other visual representation. The fertility transition is represented by two-dimensional map by wife's cohort and age with multiple layers of the birth order and of components decomposed by regression techniques. This representation is not only intuitive but also quantitatively precise. It is particularly useful when number of dimension to examine is large as is often the case with fertility study with socio-economic factors. As for our case of marital fertility, total map of the fertility rates should be constructed by preparing map layer of the proportion married, and that of illegitimate fertility.

Another metrological significance of the present study is the standardized techniques presented with the logistic regression model for controlling compositional distortion of exogenous factors on marital fertility. To avoid excessive complication in the visual understanding, effects of only two major factors, marriage delay and/or educational upgrading, are examined here. Quantitative sophistications such as addition of many other factors and inclusion of interaction terms between factors are straightforward as long as it is within the scope of regression technique. Though results from such a management should be beyond human recognition at a glance, they are effective in computational studies such as simulation and projection.

Selected References

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